Advances in Supply Chain Simulation

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The Word: Logistics

Logistique: l’application pratique de l’art de mouvoir les armées

Antoine Henri de Jomini, General
1836 AC
The Word: Logistics

Logistics is the act of moving armies.

Alfred T. Mahan, Objects of the U.S. Naval War College. An Address 1888 AC
Supply Chain Management

A Supply Chain (SC) should be viewed as a single entity that is guided by strategic decision making
Keith R. Oliver Senior VP and Michael D. Webber (Consultants in Booz, Allen & Hamilton), 1982 Supply-chain management: logistics catches up with strategy.

SCM (Supply Chain Management) as an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user
Lisa M. Ellram (ASU), Martha C. Cooper (Ohio State University) 1990

The main stated objectives of the Supply Chain Management are to lower costs and improve customer service.
Industrial Logistics

Industrial Logistics as Flow Control & Management....

....from Common Sense to Science

magna industria bellum apparavit
Cornelii Nepotis, (55 BC) de viris illustribus
The outsourcing process between main and sub-contractors is often iterated at lower levels and a good on-line multi-level control is requested, while customer needs drive the processes.
Decision Making Evolution & Tool Expectations

For Instance in an Industrial Company logistics, in order to meet lean production requirements, the Tools evolved:

- “frozen” fixed purchase orders
- open contracts regulated by agreements
- partnership with mutual info exchange
- web application enabling simulation
- Supply Chain Actor Federation
Supply Chain Simulation

Why Simulation in SCM:
- Many Stochastic Elements
- Many Elements
- Many Variables
- Many Interactions
- Many Multidependent Phenomena
- Many Different Range of Validity
- ....
Even the Simplest Case need M&S

Plant A Exporting

Empty Vessels

Full Vessels

Plant B Importing

Few Ships and Deterministic Framework

Few Ships and Stochastic Framework
Supply Chain New Challenges

Today SCM faces new Challenges such as:

• Capability to Guarantee Flows
• Sustainability
  – Economic
  – Social
  – Environmental
• Safety & Security
• …
The possible control alternatives for the Supply Chain Management are summarized as presented:

**Static**
- A Priori fixed
- Planning
- Negotiation
- Contracting

**Dynamic**
- Dynamic
- RePlanning
- Renegotiation
- New Contracting

**Distributed**
- A Priori fixed
- Planning
- Negotiation
- Contracting

**Local**
- A Priori fixed
- Planning
- Policies

**Easy**

**Critical**

**Supply Chain Net-Centric Management**

**HLA**
A Basic Aerospace Logistics as Complex Case for NSCM

• A Case for Netcentric Supply Chain Management: Executive Aircraft Logistics Goal is to procure:
  ↪ Right Items \[15,000 \text{ items/plane}\]
  ↪ in the Correct Place \[2 \text{ production sites} \]
  ↪ 21 workstations
  ↪ at Proper Time \[\text{Plane Lead Time: 2 year} \]
  ↪ Component Lead Time: 3-16 months
  ↪ with Minimum Cost \[\text{Buy Items: 3 M Euro/plane} \]
  ↪ Manpower: 15,000 hours/plane
Where are the Resources?

- In Aerospace Logistics resources are:
  - Production Sites
  - Services Centers
  - Flying Fleet
  - Component Providers
  - Transport Resources

Resources Distributed WorldWide among different Entities and Systems, Linked by the Web
What we could Exchange?

• In Aerospace, great benefits could be provided by sharing:
  ➔ Failures Data
  ➔ Spare Part Inventories
  ➔ Fleet Situation
  ➔ Configuration Evolution
  ➔ Mission Planning
  ➔ Service Planning
  ➔ Production Planning

Fleet Net-Centric Management

➔ This is a radical conceptual change feasible by current technologies with existing systems; in aerospace context this could provide terrific savings and service improvements both for Civil and Military Users
Net-Centric Management Goals

Today, Supply Chain Net-Centric Managements needs to face:
- Different Geographically Distributed Process Control Systems
- Complexity in
  - Production/Assembly Processes
  - After Sale Services Processes
- Models for Coordination of many subjects
- Dynamic Evaluation of Options and Opportunities
- Encapsulated Models for guaranteeing Proprietary Issues and Strategic Know-How as well as Classified and Confidential Data and Models

Interoperable Simulation
Interoperability as Solution

A Federation of Interacting Simulators and DSS (Decision Support Systems) located at the Actor HQ & Sites, representing the Supply Chain, supports:

- Distributed Operation Planning by Model Interoperability without exchanging Strategic Confidential Data
- On line/Real Time Control along the whole Supply Chain
- Dynamic Decision making Based on Distributed Simulation
- Alternative Solution evaluation for Operative Support
Supply Chain Netcentric Management is turning to a key aspect for the future development of the manufacturing sector.

Traditional application of the classical production management techniques cannot be directly applied.

For Supplier serving two or more party a certain degree of competition among the order priority can occur.

An Agent Based approach is supposed to be more efficient: Actors in a Supply Chain are able to “Sense and React” upon the external world stimuli.

Experiencing Agent Based Model for supporting the Optimization of a Complex Supply Chain in Aerospace Industry.
Federation Architecture

Modular Distributed System, HLA Compliant, for supporting MultiLevel Supply Chain Simulation. Stochastic Object Oriented Java Based FOM.
The agreement region is then indicated with the following simultaneous relations.

\[
\left( \chi^S_j - \chi^M_j \right)^2 < \rho_j^2 \forall j \in \{1..L \}
\]

where
- \( \chi^S_j \) is the \( j \)th Contract Specification Supplier proposal at a specific negotiation step
- \( \chi^M_j \) is the \( j \)-th Main Contractor proposal at a specific negotiation step
- \( L \) is the maximum number of proposal parameter on the negotiation.
Virtual Ports

• Training for New Device
• Engineering New Solutions
• Taking care of Security & Safety
Interoperable M&S for Plant as Supply Chain Element

- Optimizing Layout
- Considering Interference due to Physics (i.e. noise, vibration)
- Evaluating Re-Location
- Evaluating Production Transfer
- Evaluating Impact on the Supply Chain
- Virtual Analysis of the Production Site Movement
Green Logistics & Simulation

- Analyzing Sustainability and Efficiency of SC
- Improving External Marketing
- Market Reputation (Trade partners, Institutions, Consumers)
- Internal Company Reputation (i.e. survey Great place to work)
- Opportunities for Cost Reduction (i.e. solution for reducing wastes or packaging)
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Power as Product of a Service Supply Chain

- Power Business is supporting Power Plant and Equipment Development
- Most of the Equipment are sold at cost price
- 50% of the Profits comes from Service
- Logistics Services are the key strategies for improving performances and profits
RESET
River Equal Ship Simulation in Extensive Training

RESET is a project, devoted to creating a Federation for supporting training in river navigation and logistics. The Simulators includes:

• Barges
• Tanks

The RESET Federation includes the river dynamics for reproducing the maneuvering in condition affected by different streams, variable deep.
Conclusions ... ...of Part I

• Supply Chain Lean Solutions and Quick Response requires advanced distributed solutions based on Modeling & Simulation

• Interoperability and Simulation are strategic issues for succeeding in Supply Chain Management

• A Critical Issues for Success within this context:
  • Properly Define Overall Goals
  • Realistic Objectives
  • Matching Experts, Users and Developers